SECTION 9-28, SIGNING MATERIALS AND FABRICATION
September 5, 1995

Section 9-28 is revised in its entirety to read:

9-28 Signing Materials and Fabrication

9-28.1 General

Unless noted otherwise in the Plans, permanent signs shall be constructed of sheet aluminum. Permanent signs which measure 36 inches or less on a side and are to be mounted on a single post may be constructed of single 0.135 inch fiberglass reinforced plastic panels. Temporary or construction signs may be constructed of either medium or high density overlay plywood. Sign overlay panels may be either 0.050 inch aluminum or 0.075 inch fiberglass reinforced plastic panels. All signs, except internally illuminated signs, shall be reflectorized.

See ASTM D 4956 for reflective sheeting type designations. Standard control signs and guide sign borders, letters, numerals, symbols, shields, and arrows shall be in accordance with the "Washington State Sign Fabrication Manual".

All STOP, YIELD, DO NOT ENTER, WRONG WAY, FREEWAY ENTRANCE, and HIGHWAY ENTRANCE signs shall be constructed entirely of Type III or IV reflective sheeting. All M series, I series, and D-10 (Milepost) series signs and all signs with blue or brown backgrounds shall be constructed entirely of Type II reflective sheeting unless otherwise specified. Background reflective sheeting for all other signs shall be as noted in the plans. Sign legends for all other signs shall be constructed of Type III or IV reflective sheeting. Sign legends include: borders, letters, numerals, symbols, shields, and arrows. Reflective legend sheeting types shall not be mixed on individual signs.

9-28.1(1) Basis for Acceptance

Reflective sheeting shall be accepted on the basis of tests performed by the Materials Laboratory, or at the option of the Engineer, a manufacturerís certificate of compliance as outlined in Section 1-06.3. This certificate shall verify that the product meets all the requirements of Section 9-28.12. The basis for acceptance of aluminum sign blanks and panels shall be a mill test certificate from the aluminum manufacturer attesting to the correct alloy and temper of the metal supplied. At the option of the Engineer, laboratory tests may also be performed to confirm metallurgical data.

It is expressly understood that the furnishing of certificates of compliance will not relieve the Contractor from the obligation to replace materials found defective after delivery to the project, nor will they prevent the Engineer from sampling material when it arrives on the project and subjecting it to such laboratory tests as they may deem appropriate or significant.

9-28.1(2) Inspection

All signs will be inspected at the fabricator's plant before shipment to the project. The inspection shall not be made until all materials have been tested and approved. Signs without a "FABRICATION APPROVED" decal will not be installed on the project with the exception of double-faced signs which do not receive decals or fabricator's stickers.

9-28.2 Manufacturer's Identification and Date

All signs shall show the manufacturer's name and date of manufacture on the back. Destination, distance, and large special signs shall show the

manufacturer's name and the date of manufacture on the back, and the number of the sign as it appears in the plans in 3 inch series C black letters. Hand painted numbers are not permitted.

9-28.3 Corner Radius

All regulatory and warning signs shall have rounded corners with the exception of stop signs. Information and guide signs may have square cut corners. Borders for signs having square cut corners shall have a corner radius approximately 1/8 of the lesser side dimension of the sign up to a maximum radius of 12 inches. For signs with rounded corners, the borders shall be concentric with the rounded corners.

9-28.4 Extruded Windbeams and "Z" Bar

All multiple post and multiple panel signs shall be constructed and installed with horizontal extruded windbeams and "Z" bar, when required, as shown in the Plans or the Standard Plans. All bolt and rivet heads visible on the sign face shall be anodized or painted to match the sign area immediately surrounding the bolt or rivet head. Extruded wind beams and "Z" bar shall be accepted on the basis of certificate of compliance from the manufacturer. Materials shall be as designated in Section 9-28.11.

9-28.5 Letter and Spacing Formula

Letter and arrow sizes shall be as specified in the plans. Spacing formulas shall be those furnished by the manufacturer of the letters.

9-28.6 Destination Sign Messages

Destination sign messages, borders, shields, and symbols shall be direct applied unless other wise noted in the sign plans. All message components shall be one piece construction unless the least dimension exceeds available sheeting widths. All components shall have smooth, sharp cut edges. Components which are torn, wrinkled, or exhibit poor workmanship, will not be permitted.

Where specifically noted in the plans, demountable components shall be utilized. Demountable messages, borders, shields, and symbols shall consist of the appropriate sheeting, or if non-reflective, paint applied to 0.032 inch aluminum. Shields and symbols shall be applied to 0.050 inch aluminum.

9-28.7 Process Colors

Transparent and opaque process colors used in silk screening sign messages shall be as recommended by the manufacturer. When properly applied, process colors shall perform satisfactorily for the expected life of the sheeting. Applied colors shall present a smooth surface, free from foreign material, and all messages and borders shall be clear and sharp. When applied, transparent colors shall have the same retroreflective values, type, and color as the sheeting to which it's applied. There shall be no variations in color, and overlapping of colors will not be permitted.

Properly applied and cured process colors shall exhibit no blistering, bubbling, or loss of color or transparency when cleaned with a mild non-abrasive detergent solution. Minor loss of color may be detected when solvents such as kerosene, mineral spirits, heptane, or VM&P Naphtha are used to clean severely contaminated signs; e.g., paint vandalism. However, the colors shall not blister, bubble, peel, or be easily removed.

9-28.8 Sheet Aluminum Signs

Sheet aluminum signs shall be constructed of material conforming to ASTM B 209 alloy 6061-T6 or alloy 5052-H36 or H38. Alloy 5005-H34 may be used for sign overlays.

After the sheeting has been fabricated, the sheeting for all multiple panel signs shall be degreased, etched by immersion for a minimum of 5 minutes in a 6 ounce per gallon caustic etch solution at 120 F, followed, in order, by a water rinse, de-oxidation, water rinse, hot water rinse, and drying. The etching process shall produce a dull aluminum finish on both sides of the panel which will last the life of the sign. The treated panel surface shall be compatible with the opaque and reflective sheeting to be applied in accordance with the specifications. The Contractor may use an Alodine 1200 application for single panel signs in lieu of the above treatment. Aluminum signs over 12 feet wide by 5 feet high shall be comprised of vertical panels in increments of 2, 3, or 4 feet wide. No more than one 2 and/or 3 foot panel may be used per sign. The Contractor shall use the widest panels possible. All parts necessary for assembly shall be constructed of aluminum, galvanized, or stainless steel in accordance with the plans. Sheet thickness shall be as follows:

Maximum Horizontal Dimension	Sheet Aluminum Thickness
Overlay panels	0.050 inch
Up to 20 inches	0.063 inch
20 inches to 36 inches, inclusive	0.080 inch
Over 36 inches	0.125 inch

The side dimension for a diamond shaped warning sign is considered to be the maximum horizontal dimension.

Before placing aluminum in contact with untreated steel, the steel surfaces shall be protected by proper cleaning and painted with a zinc-dust zinc oxide primer A-6-86 and two coats of aluminum paint D-1-57.

Metal shall be handled by device or clean canvas gloves between all cleaning and etching operations and the application of reflective sheeting.

9-28.9 Fiberglass Reinforced Plastic Signs

Fiberglass reinforced plastic signs and overlay panels shall be constructed of a fiberglass reinforced thermoset polyester laminate. The sign panel shall be acrylic modified and UV stabilized for outdoor weathering ability.

The sign panel shall be stabilized to prevent the release of migrating constituents (such as solvents, monomers, etc.) over the expected life of the sign. The sign panel shall contain no residue release agents on the surface of the laminate so neither migrating constituents or release agents will be present in amounts which will interfere with any subsequent bonding operations.

The sign panel shall not contain visible cracks, pinholes, foreign inclusions, or surface wrinkles that would affect implied performance, alter the specific dimensions of the panel, or otherwise affect its serviceability.

The sign panel surface shall be wiped clean with a slightly water dampened cloth before applying reflective sheeting.

9-28.9(1) Mechanical Properties

All mechanical properties are stated as minimum requirements. The mechanical properties are measured in both the line direction of the panel and at 90 degrees to the line as noted in the appropriate ASTM test referenced.

Mechanical Property	Ave. Min. Requirement	ASTM Test
Tensile Strength	10.0 psi x 103	D638
Tensile Modulus	1.2 psi x 106	D638
Flexural Strength	20.0 psi x 103	D790
Flexural Modulus	1.2 psi x 106	D790
Compression Strength	32.0 psi x 103	D695
Compression Modulus	1.4 psi x 106	D695
Punch Shear	13.0 psi x 103	D732

9-28.9(2) Physical Properties

Sign Panels are to be 0.135 inch thick. Overlay panels are to be 0.075 inch thick. Panel thickness tolerance shall be plus or minus 0.005 inch. Panel tolerance on nominal length and width shall be plus or minus 1/8 inch for dimensions of 12 feet or less and shall be within 1/8 inch of square per 12 feet of length when measured in accordance with ASTM D3841.

Panels shall be manufactured with smooth surfaces on both top and bottom of the panel.

Panel flatness of a 30 inch by 30 inch panel shall be measured by hanging the panel diagonally in suspension. The maximum deflection measured diagonally, parallel and perpendicular to the panel by lines drawn through the center of the panel, shall not exceed 12 millimeters. The panel shall then be hung diagonally in suspension in an oven for 48 hours at 180 F. The maximum deflection shall again be measured as previously noted and shall not exceed 12 millimeters. All measurements shall be made when panels are at ambient temperature.

Panels shall be pigmented to a visually uniform gray color within the Munsel^{R} range of N.7.5/to N.8.5/.

Panels shall have a maximum coefficient of lineal thermal expansion of 1.8 X 10^{-5} in./in./ F when tested in accordance with ASTM D696.

Panels shall be classified as to a minimum Grade II (weather resistant) panel as specified in ASTM D3841 following 3,000 plus or minus 100 hour weatherometer test.

Panels shall contain additives designed to be less responsive to fire ignition and flame propagation. As such, the extent of burning shall not exceed 1.0 inch when tested in accordance with ASTM, Method D635.

Panels shall resist the impact energy of 20 foot-pounds applied with a hemispherical tipped object 1 inch in diameter.

The panels thermal stability for strength and impact resistance qualities shall not be appreciably affected over a temperature range of -65 F to 212 F.

Fiberglass reinforced plastic panels for signs shall be accepted on the basis of a certificate of compliance from the manufacturer as outlined in Section 1-06.3.

9-28.10 Plywood Signs

Plywood signs shall be constructed of medium or high density plywood and shall conform to the current requirements as set forth in "Production Standard for Construction and Industrial Plywood" published by the Product Standards Section of the National Bureau of Standards. The plywood shall be free of contaminants.

Face veneers shall be Grade B or better.

Core and crossband veneers shall be solid. Core veneers shall be jointed, and core gaps shall not exceed 1/8 inch in width.

The entire area of each contacting veneer surface shall be bonded with a waterproof adhesive that meets the requirements for exterior type plywood.

High density plywood overlay shall have a minimum weight of 60 pounds per thousand square feet of surface, shall be at least 0.012 inch thick before pressing, and have a minimum resin content of 45 percent based on the volatile free weight of fiber and resin exclusive of glue line.

Medium density plywood overlay shall have a minimum weight of 58 pounds per thousand square feet of surface. It shall be at least 0.012 inch thick after application and have a minimum resin content of 17 percent based on the volatile free weight of resin and fiber exclusive of glue line.

The overlay shall have a sufficient resin content to bond itself to the plywood.

Plywood sign surfaces shall be cleaned thoroughly with lacquer thinner, heptane, benzene, or solvent recommended by the reflective sheeting manufacturer. The surface shall be sanded with light sandpaper or steel wool and wiped dry and clean with a clean cloth. The reflective sheeting shall then be applied. Plywood signs over 12 feet wide by 5 feet high shall be comprised of vertical panels in increments of 4 feet or less. The Contractor shall use the widest panels possible.

Plywood Panel Thickness

Signs: up to 18 inches inclusive in width	3/8 inch minimum
Over 18 inches to 36 inches inclusive in width	1/2 inch minimum
Over 36 inches in width	5/8 inch minimum
Plywood shields on destinations signs	3/8 inch minimum
Multiple panel signs	5/8 inch minimum

9-28.11 Hardware

Bolts, nuts, and washers shall be of the same material for each attachment. All parts necessary for assembly shall be constructed of the materials listed below:

Hardware	Specification
Bolts	ASTM F 468 2024-T4 Aluminum
	ASTM A 307 Steel ASTM F 593 Stainless Steel
Washers	ASTM B 209 2024-T4 Aluminum
	AASHTO M 183 Steel ASTM F 594 Stainless Steel
Nuts	ASTM F 467 2024-T4 Aluminum
	ASTM A 307 Steel
	ASTM F 593 Stainless Steel
Locknuts	ASTM F 467 2024-T4 Aluminum
	ASTM A 307 Steel ASTM F 593 Stainless Steel
Rivets	ASTM B 316 6061-T6 Aluminum
	ASTM B 6053-T61 Aluminum
Post Clips	ASTM B 179 356-T6 Aluminum
Wind Beam	ASTM B 221 6061-T6 Aluminum
Angle and "Z" Bar	ASTM B 221 6061-T6 Aluminum
	AASHTO M 183 Steel
Strap and Mounting Bracket	ASTM A 412, Type 201

All steel parts shall be galvanized per ASTM A 123. Steel bolts and related hardware shall be galvanized per ASTM A 153 or B 695.

9-28.12 Reflective Sheetings

Type I and Type II reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat outer surface. Type III and Type IV reflective sheeting shall consist of spherical or prismatic lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface. All sheeting shall be weather

resistant and have a protected pre-coated adhesive backing. Type II reflective sheeting shall contain an identifying marking, such as a water mark, which is visible after sheeting application. The marking shall not adversely affect the performance or life of the sheeting.

The reflective sheeting shall have the following minimum coefficient of retroreflection values at 0.2 degrees and 0.5 degrees observation angle expressed as average candelas per foot-candle, per square foot of material. Measurements shall be conducted in accordance with ASTM E 810.

Type I Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	SILVER WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	70	50	25	9.0	14	4.0	1.0
0.2°	+30°	30	22	7.0	3.5	6.0	1.7	0.3
0.5°	-4°	30	25	13	4.5	7.5	2.0	0.3
0.5°	+30°	15	15	4.0	2.2	3.0	0.8	0.2

Type II Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	SILVER	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	140	100	60	30	30	10	5.0
0.2°	+30°	60	36	22	10	12	4.0	2.0
0.5°	-4°	50	33	20	9.0	10	3.0	2.0
0.5°	+30°	28	20	12	6.0	6.0	2.0	1.0

Type III Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	SILVER	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-4°	250	170	100	45	45	20
0.2°	+30°	150	100	60	25	25	11
0.5°	-4°	95	62	30	15	15	7.5
0.5°	+30°	65	45	25	10	10	5.0

Type IV Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	SILVER	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	250	170	100	35	35	20	7.0
0.2°	+30°	80	54	34	9	9	5.0	2.0
0.5°	-4°	135	100	64	17	17	10	4.0
0.5°	+30°	53	37	22	6.5	6.5	3.5	1.4

The wet performance measurements on unweathered sheeting shall be conducted in accordance with one of the following methods:

(1) The standard rainfall test specified in Federal Specification LS 300C and the brightness of the reflective sheeting totally wet by rain shall not be less than 90 percent of the above values.

(2) Samples shall be submerged in a tank of clean water (approximately 72 F) for a period of 5 minutes. Reflex-reflective performance of the sheeting shall be viewed in a darkened room by reflected light through the surface of the water or through a transparent plane surface of the tank parallel to the sample surface. Light source shall be such as a hand flashlight held close to the eye. The wet sheeting shall show no apparent loss of reflective performance as compared to dry material.

The diffuse day color of the reflective sheeting shall be visually evaluated by comparison with the applicable Highway Color Tolerance Chart. Color comparison shall be made under north daylight or a scientific daylight having a color temperature from 6500 degrees to 7500 degrees Kelvin. Daytime color evaluation shall be illuminated at 45 degrees and viewed at 90 degrees. There shall be no significant color shift when viewed under nighttime (retroreflective) conditions.

The reflective sheeting shall have a pre-coated pressure sensitive adhesive (Class 1) or a heat-activated adhesive (Class 2) either of which will adhere to flat, clean surfaces without necessity of additional adhesive coats on the reflective sheeting or application surface. Chemical activators shall not be used to activate Class 2 adhesive. The pre-coated adhesive shall be protected by an easily removed liner which, when removed, shall not have a staining effect on the reflective sheeting and shall be mildew resistant. The protective liner attached to the adhesive shall be removable by peeling without soaking in water or other solvents and shall be easily removed after storage for 4 hours at 150 F under weight of 2.5 psi. The sheeting with liner removed, conditioned for 24 hours at 72 F and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 1/8 inch diameter mandrel with the adhesive side contacting the mandrel. For ease of testing, talcum powder my be spread on the adhesive to prevent sticking to the mandrel. The sheeting surface shall be smooth and flat to facilitate self-cleaning in the rain, regular cleaning, and wet performance, and exhibit 85 degrees glossmeter rating of not less than 50 when tested in accordance with ASTM D 523. The sheeting surface shall be readily processed and compatible with transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and application. The sheeting shall permit cutting and color processing at

temperatures of 60 F to 100 F and 20 to 80 percent RH. The sheeting shall be heat resistant and permit force curing without staining of unapplied sheeting at temperatures up to 150 F and up to 200 F on applied sheeting. The sheeting surface shall be solvent resistant to permit cleaning by wiping with a clean soft cloth dampened with VM&P Naphtha or mineral spirits.

The adhesive shall form a durable bond to smooth, corrosion and weather resistant surfaces and permit the reflective sheeting to adhere securely, 48 hours after application at temperatures of -30 F to 200 F. The adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and prevent its shocking off when subjected to an impact energy of 20 ft. lbs. applied with a hemispherical tipped object 1 inch in diameter at 0 F. The test specimen shall be applied to aluminum backing not less than 0.080 inch thick and having a dimension of not less than 4 inches square. During testing, the specimen shall be supported on a 3 inch diameter ring.

The adhesion test shall be the same as outlined in Federal Specification LS 300C except that in addition to testing at room temperature, the adhesion shall also be tested at 0 F and 180 F.

The resistance to accelerated weathering shall be as described in Federal Specification LS300C except the weathering apparatus and procedure shall be in accordance with ASTM G 53.

The reflective sheeting shall be sufficiently flexible to be cut to shape easily and permit application over, and conform to, moderate shallow embossing characteristic of certain sign borders and symbols. The tensile strength of the sheeting shall be 5 to 20 pounds per square inch width when conditioned for 48 hours in accordance to ASTM D 685 and tested in accordance with ASTM D 828. Following liner removal, the reflective sheeting shall not shrink more than 1/32 inch in ten minutes nor more than 1/8 inch in 24 hours in any dimension per 9 inch square at 72 F and 50 percent relative humidity.

The sheeting, when applied according to manufacturer's recommendations to cleaned and etched .020 inch X 2 inch X 8 inch aluminum, conditioned (24 hours) and tested at 72 F and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 3/4 inch diameter mandrel.

9-28.12(1) Application

The reflective sheeting shall be applied in the manner specified by the sheeting manufacturer. The applied sign face shall not have bubbles, wrinkles, or foreign material beneath the reflective sheeting.

9-28.12(2) Edge Treatment

All edges and splices of reflective sheeting signs shall be coated with an edge sealer when recommended by the manufacturer of the reflectorized sheeting.

9-28.12(3) Splices and Color Matching

Splicing of reflective sheeting shall not be permitted on signs or panels with dimensions up to and including 48 inches in height or width unless the reflective sheeting specified does not come in this width, then the widest width material shall be used. When sheeting joints are required, they shall be lap-jointed with the top sheet overlapping the bottom sheet by no less than 3/16 inch. The fabricator shall endeavor to use the least number of seams possible with the

horizontal lap preferable. Roller applied or reverse screened sheeting may be butt-jointed with joint gap not to exceed 1/32 inch. Color matching of adjacent sheets of reflective sheeting comprising a sign shall be accomplished without a noticeable difference in color. No borders shall be spliced other than the splice of the tangent border to the corner radius.

9-28.13 Demountable Prismatic Reflectorized Message and Borders

The letters, digits, and alphabet accessories shall consist of embossed 0.040 inch thick sheet aluminum frames conforming to ASTM B 209 grade 3003-H14 in which prismatic reflectors are installed to prevent their displacement in handling or service. Letters in which reflectors are assembled by means of tape are unacceptable. The plastic reflectors face shall be colorless and be entirely smooth to present a water repellent and dirt resistant surface. The area indicating the letter shape that is not reflectorized shall be white for maximum daytime contrast with the sign background. All letters shall be free of any imperfections and shall present a high quality appearance. Demountable prismatic border shall be comprised of a minimum length of 2 feet with allowance of one shorter section between each corner radius.

Letters shall be fastened to the sign with aluminum screws or blind rivets conforming to ASTM B 209 grade 2024-T4.

The coefficient of retroreflection of each reflex reflector intended for use in cutout letters, symbols, and accessories shall be equal to or exceed the following minimum values with measurements made with reflectors spinning.

Observation Angle (degrees)	Entrance Angle (degrees)	Coefficient of Retroreflection Candle Power/Square Inch/Foot Candle
0.1	0	14.0
0.1	20	5.6

Failure to meet the specific minimum values shall constitute failure of the reflector being used. Upon failure of more than two of the 50 samples tested, a resample of 100 reflectors shall be tested. Failure of more than four of these samples shall be cause for rejection of the lot.

9-28.14 Sign Support Structures

All sign support structures shall be constructed as shown in the plans.

9-28.14(1) Timber Sign Posts

At the Contractor's options, timber sign posts and mileposts shall be untreated Western cedar, treated Douglas fir, or treated Hem-fir meeting the grades specified in Section 9-09.2. Douglas fir and Hem-fir posts shall be given a treatment in accordance with Section 9-09.3(4). Preservative retention shall be a minimum of 0.40 pounds per cubic foot. Penetration shall be a minimum of 3/8 inch or 90 percent of sapwood for posts under 5 inches thick and 1/2 inch or 90 percent of sapwood for posts 5 inches or thicker. S4S finish is not required for unpainted posts.

9-28.14(2) Steel Structures and Posts

Steel sign structures and posts shall be galvanized unless noted otherwise in the plans. Metal surfaces shall not be painted. Minor fabricating and modifications necessary for galvanizing will be allowed if not detrimental to the end product as determined by the Engineer. If such modifications are contemplated, the

Contractor shall submit to the Engineer, for approval, six copies of the proposed modifications, prior to fabrication. Fabrication and erection shall conform to the applicable requirements of Sections 6-03 and 9-06.

9-28.14(3) Aluminum Structures

Welding of aluminum shall be in accordance with Section 1.5 of the "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals," AASHTO 1994.

Aluminum materials shall conform to ASTM B 209 grades as follows: the filler alloy shall be 4043, 5365, or 5556 for welding base metals 6061 or 6063 to 6061, 6063, 356, or A356. Filler alloy for welding base metal 5086 shall be 5356 or 5556.

9-28.15 Sign Lighting Luminaires

Sign lighting luminaires shall have a cast aluminum housing and door assembly with a polyester paint finish. All external bolts, screws, hinges, hinge pins, and door closure mechanisms shall be series 300 grade stainless steel.

The housing shall encase a reflector, lamp socket, and ballast. It shall have a front entry (the side facing the sign) suitable for 1/2 inch conduit and mounting holes for attaching to a fixture mounting plate. Any additional enties shall have suitable plugs. The sign lighting luminaire shall be supported by a lighting bracket assembly as detailed in the plans. If the sign structure includes a maintenance walkway, the luminaire fixture mounting plate shall be bolted to the walkway grating. Condensation drain holes shall be provided as recommended by the manufacturer.

The door shall be hinged to the housing on the side of the fixture away from the sign panel and shall be provided with two captive closure devices. The door shall be provided with the means to allow the door to be locked in the open position 70 to 90 degrees from the plane of the door opening. The juncture of the door and housing shall be gasketed to provide a rain tight and dust tight joint.

Refractors shall be manufactured from heat resistant borosilicate glass. The refractor shall be shielded so that no light source is visible from the sign viewing approach. The shield shall be an integral part of the door assembly. When called for in the plans, fixtures shall be provided with a wire guard to prevent damage to the refractor.

The reflector shall be manufactured from one piece polished (Alzak or equal) aluminum. The reflector shall be designed so condensed water will drain away.

The light source shall be a 175 watt deluxe phosphor coated mercury vapor lamp. The lamp socket shall be a porcelain enclosed mogul type containing integral lamp grips to ensure electrical contact under conditions of normal vibration. The center contact shall be spring loaded. The shell and center contact shall be rated for 1500 watts, 600 volts.

Ballasts shall be suitable for operating a 175 watt metal halide lamp and shall conform to the requirements of Section 9-29.9. The crest factor shall remain within a range of 1.6 to 1.8. Ballasts shall have a design life of no less than 100,000 hours.

Ballasts shall consist of separate components, each of which shall be capable of being easily replaced. All conductor terminals shall be identified as to the component terminal to which they connect. Heat generating components shall be mounted to use the portion of fixture on which they are mounted as a heat sink.

Capacitors shall be separated from heat generating components or thermally shielded to limit the case temperature to 90°C. Each fixture shall be provided with a fusible terminal block. Fuses shall be 10 amp, 250 volt for 120 volt circuits, and 5 amp, 600 volt for 240 and 480 volt circuits. The primary voltage shall be as indicated in the plans. Photometric performance shall be as follows:

The ratio of the maximum to minimum illuminance level on a panel 10 feet high by 16 feet wide shall not numerically exceed 5:1 approaching 1:1. In addition, the illuminance gradient shall not numerically exceed 2:1, illuminance gradient being defined as the ratio of the minimum illuminance of 1 square foot of panel to that of any adjacent square foot of panel. This performance shall be obtained when the fixture is mounted 1 foot below the bottom edge of the sign and 5 feet out.

The average to minimum uniformity ratio for a panel as dimensioned above shall not numerically exceed 3:1. Average initial illuminance shall exceed 10 foot-candles for a mercury vapor lamp of 175 watts as specified.